PRELIMINARY INSTRUCTION MANUAL FOR AP-3A POWER SUPPLY.

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AP-3A POWER SUPPLY INSTRUCTION MANUAL

1.0 General Information

1.1 Introduction

The AP-3A is a lightweight power supply capable of supplying 12 volts dc to an AT-3 transmitter, or recharge a 12 volt dc battery. The ac power source for the AP-3A can have a frequency range of 50 to 400 cycles per second, and a voltage range of 75 to 270 volts rms.

This manual is divided into sections. These consist of physical description, operating , instructions, theory of operation, and parts list.

1.2 Electrical Specifications

Input Power - 75 to 270 vac rms

50 to 400 cps

Ambient Temperature - 0°C. to 50°C.

Output Voltage - No load - 12.5 vdc±2-1/2% (power supply)
- 15 vdc±5% (battery charger)
Full Load 12 vdc±2.5% (Power supply)

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Output Ripple from Power Supply - 125 mv at full load

Maximum Output Power - 10A at 12 vdc

Duty Cycle - 50% for one hour

Weight 7 lbs.

1.3 **Controls and Indicators**

"ON" switch - push button (located on left end plate)

"OFF" switch - push button (located on left end plate)

F1 8A 3AB fuse (located on left end plate)

F2 3A8AG fuse (located on right end plate)

"PWR ON" light (located on left end plate)

"BATT" light (located on left end plate)

"POWER SUPPLY 12 VOLTS DC" connector (located on right end plate)

"BATTERY 15 VOLTS DC" connector (located on right end plate)

Power Cord (located on left end plate)

TPI (red) test point (located inside left end plate)

TP2(black) test point (located inside left end plate)

2.0 Operating Instructions

2.1 Equipment Interconnection

The AP-3A contains two connectors for operation with either the AT-3 transmitter or charging a battery pack. For operation with the AT-3, the connector labeled "POWER SUPPLY" 12 volts d. c. is used. For use as a battery charger, the connector labeled "BATTERY", 15 volts d. c. is used.

2.2 Operating Instructions

2.2.1 Power Supply

1. Unwind power cable from a compartment located at the left hand side of the AP-3A case and connect to an a. c. power source ranging from 50 to 400 cps at 75 to 270 volts rms.

2. To turn unit on, press red "ON" button and red "PWR ON" lamp will light.

3. To turn untt off, press black "OFF" button.

4. Connect AT-3A, as explained in paragraph 2.1.

2.3 MAINTENANCE PROCEDURES.

1. DO NOT USE GROUNDED TEST EQUIPMENT FOR MAKING MEASUREMENTS ON THE PHASE CONTROLLED RECTIFIER OR D.C. CONVERTER CIRCUIT. SEE PARAGRAPH 3.0 AND FIG (321764)

2.2.2 Battery Charger

1. Connect battery (see paragraph 2.1) and turn on AP-3A, as explained in paragraph 2.2.1.

2. The battery charging rate is indicated by a light labeled "BATT" located on the left hand side of the AP-3A. When this lamp is bright, the battery voltage is low. When the lamp goes off, the battery is fully charged.

3.0 Theory of Operation

3.1 Introduction

This section contains the theory of operation for the AP-3A power supply. It is divided into a general discussion of the power supply, followed by a detailed discussion of each major section within the power supply.

3.2 AP-3A Power Supply Theory of Operation

3.2.1 General Theory (Ref. Block Diagram Fig. 1)

The AP-3A power supply operates by converting ac to dc with a

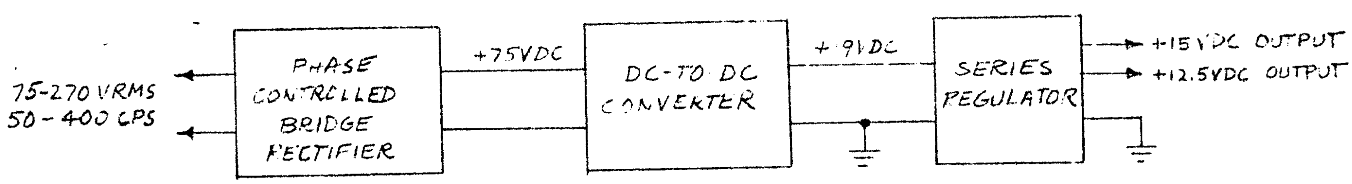

FIG. 1 - BLOCK DIAGRAM - AP-3A PWR. SUP.

phase controlled rectifier and then reconverting back to ac at a high frequency. This higher frequency ac is again rectified and regulated. The major sections of the power supply are the phase controlled bridge rectifier, the dc to dc converter, the series regulator, and the battery charger.

AC to dc conversion is accomplished by the phase controlled bridge rectifier. A phase controlled rectifier was used due to the wide range of input voltage. The 75 vdc output level was selected for two reasons: 1) for minimum filter capacitance required, the voltage level should be high, but to maintain this level with 75 vac input and still have phase control a 75 vdc level was selected; 2) to obtain the proper output level and provide isolation of the output from the input a dc to dc converter is utilized. A series regulator follows to maintain constant output voltage. Instead of applying a load to the Power Supply connector, the power supply will function as a 12v. battery charger by attaching a battery to the Battery connector. The charge condition is indicated by a lamp.

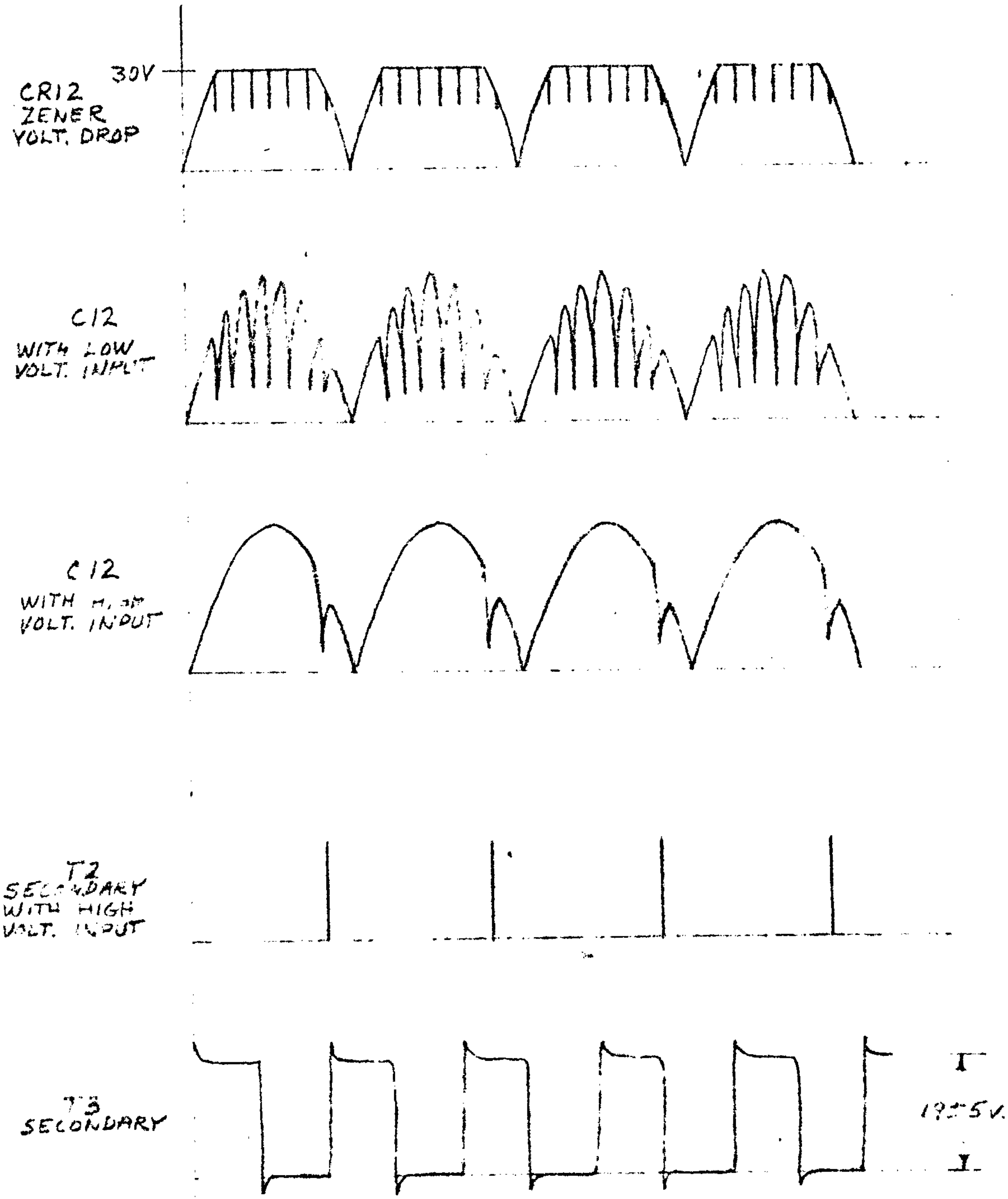

FIG. 2 - WAVEFORMS

3.2.2 Detailed Theory (Ref. Schematic Drawing 321764)

Phase Controlled Bridge Rectifier. The phase controlled bridge rectifier consists of a full wave bridge rectifier with an SCR (silicon controlled rectifier) in two of the legs and the associated SCR triggering circuit.

The SCR firing is delayed in proportion to the input voltage, that is, with a low input voltage the triggers will occur near the beginning of each half cycle while with successively higher input voltages the triggers will occur successively later in each half cycle. The firing occurs at the proper time to maintain the output at +75vdc. For waveforms, see Figure 2.

The SCR trigger pulses are generated by the firing of a unijunction transistor, Q1, and are transformer coupled to the SCR's by T2. The firing of Q1 is synchronized to the input frequency by having its supply voltage be an unfiltered full wave rectified portion of the input voltage. The delay of the trigger is determined by the rate of voltage buildup at the emitter of Q1 to its firing voltage. The voltage at the emitter of Q1 is controlled in two ways. One is by switching capacitor C13, varying the RC time constant, the other is by shunting the capacitance with a variable resistance Q2, which varies the charging level of the capacitance. Output variations in excess of +75 vdc are coupled through the 75v zener diode CR7 to the base of Q2. The resulting collector current lowers the charging voltage level at the emitter of Q1, thereby delaying the firing of Q1. The SCR's then fire later in the cycle, reducing the output voltage. Due to the limited range of this control and the wide range of input voltage and frequency the time constant to the emitter of Q1 is also changed. For low frequency C13 is switched in parallel with C12 to provide a longer initial delay. A 7.5v portion of the input voltage is taken by zener diode CR12 and connected to a voltage divider of 50K ohms and 10 henries. For low frequencies the rectified and filtered voltage across the 10 henries is small and Q3 turns on connecting C13 in parallel with C12. With a higher input frequency, the voltage across the 10 henries is sufficient to cut off Q3, disconnecting C13.

To insure that the triggering circuit has gained control, preventing excessive output voltage, a 100 ohm resistor, R2 , slows the charging of filter capacitor C7 during initial input connection. When C7 has charged to +75 volts, relay K1 will energize by depressing the ON switch. K1 holds in, by-passes R2 and applies +75 volts to the converter. The power supply turns off by depressing the OFF switch which unlatches K1. The capacitors on the input lines prevent radiation outside the power supply case.

DC to DC Converter

The dc to dc converter produces +19 vdc from +75vdc. Transistors Q8, Q9, Q10, and Q11 with the primary of transformer T3 act as an astable multivibrator. By the switching action of the multivibrator the +75vdc is converted to a square wave with a frequency of approximately 5 kc. (For waveform see Figure 2.) The conversion to ac allows this chopped voltage to be coupled to the secondary of the transformer. When the voltage is first applied transistors Q8 and Q11 will start conducting because of the small forward bias supply by resistors R33 and R34. The increasing collector current of Q8 and Q11 flowing through the transformer induces a back biasing feedback voltage to Q9 and Q10 preventing conduction. The same current induces a forward biasing feedback voltage to Q8 and Q11, causing increased conduction. When the transformer saturates the feedback voltage decreases and conduction can no longer be supported. The flux now decreases, inducing opposite polarity feedback voltages to turn off Q8 and Q11 and turn on Q9 and Q10. The second half cycle is generated in a similar manner with Q9 and Q10 the conducting transistors. The square wave output of transformer T2 is full wave rectified by a bridge circuit and filtered. The resulting +19vdc is then applied to the series regulator.

Series Regulator

The series regulator maintains the output at a constant +12.5vdc for both variations in load and the nominal +19vdc input to the regulator.

The regulator consists of two paralleled transistors in series with the output driven by a two stage amplifier with a 12 volt zener diode as a reference voltage.

If the output voltage tries to increase a forward biasing current is coupled through the zener diode to the base of the 2N336A transistor. The 2N336A transistor conducts more, shunting part of the current being supplied to the base of the 2N656 transistor. The decreased current into the base of the 2N656 results in less emitter current and hence less current into the bases of the two WX118UA transistors. The WX118UA transistors conduct less current, increasing their collector to emitter drop, thereby lowering the output voltage. The 0.25 ohm resistors in the collectors of the WX118UA transistors are to insure that the currents through the two paralleled transistors are equal. The inductor and capacitor on the +12.5 vdc output are to prevent radiation.

Battery Charger

Without a load applied to the Power Supply connector a 12 volt battery can be attached to the Battery connector and the power supply will function as a battery charger. Removing the load removes the 12 volt zener diode from the series regulator so that the reference voltage is now a 15 volt zener diode. The +15 vdc output voltage is connected to the Battery connector through R17 and R18 a current limiting resistor. The battery charge condition is indicated by a lamp in parallel with the current limiting resistor. As the battery charges, less voltage is dropped across the resistor and the battery lamp becomes dimmer.